User manual

UM EN IB IL PM 3P/N/EF-PAC

Inline Modular power measurement terminal: connection methods, operating modes, process data, and PCP

PHOENIX CONTACT
INSPIRING INNOVATIONS

User manual

Inline Modular power measurement terminal: connection methods, operating modes, process data, and PCP

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Revision: 00

Order No.: —

This user manual is valid for:

Designation	Order No.
IB IL PM 3P/N/EF-PAC	2700965

Please observe the following notes

User group of this manual

The use of products described in this manual is oriented exclusively to:

- Qualified electricians or persons instructed by them, who are familiar with applicable standards and other regulations regarding electrical engineering and, in particular, the relevant safety concepts.
- Qualified application programmers and software engineers, who are familiar with the safety concepts of automation technology and applicable standards.

Explanation of symbols used and signal words

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety measures that follow this symbol to avoid possible injury or death.

There are three different categories of personal injury that are indicated with a signal word.

DANGER This indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING This indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION This indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

This symbol together with the signal word **NOTE** and the accompanying text alert the reader to a situation which may cause damage or malfunction to the device, hardware/software, or surrounding property.

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1 Connection methods

Whatever connection method is used, the currents and voltages can be connected directly or via transformers/transducers. The following example shows the wiring for a four-wire three-phase network with measurement of the neutral conductor current.

Make sure that the potential of a connected neutral conductor is close to ground and does not exceed 45 V AC to ground.

1.1 Direct connection

The power measurement terminal has the advantage that currents can be connected directly, i.e., live. Direct connection is possible up to a nominal current of 5 A and a phase voltage of up to 400 V.

Moreover, the measuring range can be switched between 1 A and 5 A.

Configuration:

– Primary and secondary phase conductor voltage = 0 (default)
– Primary phase current = 0 (default)
– Secondary phase current = 1 A or 5 A for measuring range selection

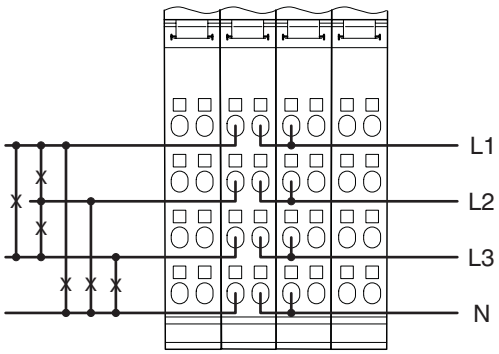

Figure 1-1 Direct connection

1.2 Connection with current transformers

Use current transformers when connecting nominal currents higher than 5 A.

Ground the transformers for safety and to reduce secondary sources of interference.

Configuration:

– Primary and secondary phase conductor voltage = 0 (default)
– Primary and secondary phase current dependent upon the current transformer used

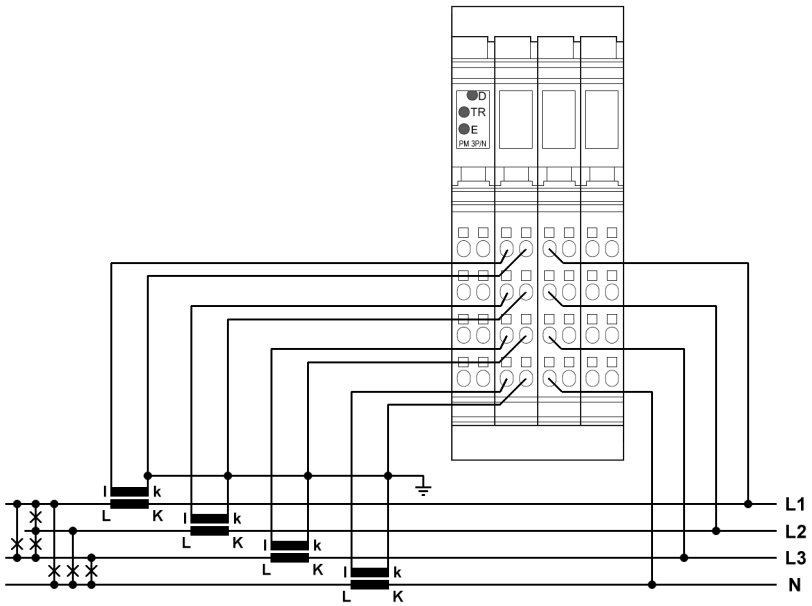

Figure 1-2 Connection with current transformers

1.3 Connection with current transformers and voltage transducers

Voltages

To ensure electrical safety at voltages higher than 400 V_{LN}/690 V_{LL} (measuring category CAT II) or 230 V_{LN}/400 V_{LL} (measuring category CAT III), use voltage transducers for the connection.

Ground the secondary neutral conductor connection of the voltage transducers.

In high-voltage networks, use single-position isolated voltage transducers grounded at the cold end (connection X instead of V).

Currents

To ensure electrical safety at voltages higher than 400 V_{LN}/690 V_{LL} (measuring category CAT II) or 230 V_{LN}/400 V_{LL} (measuring category CAT III), use current transformers for the connection.

Ground the current transformers.

Configuration:

– Primary and secondary phase conductor voltage dependent upon the voltage transducer used
– Primary and secondary phase current dependent upon the current transformer used

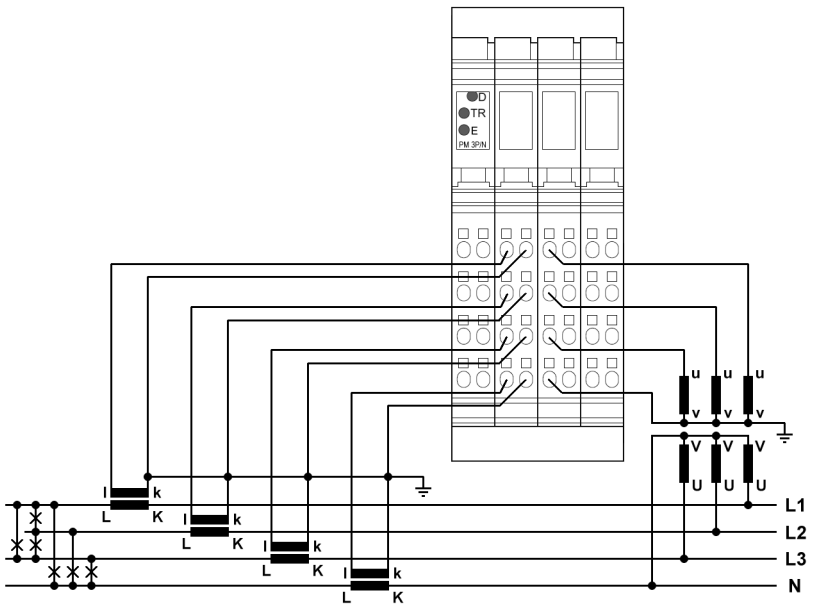

Figure 1-3 Connection with current transformers and voltage transducers

1.4 Configuration of current and voltage inputs

Configure the current and voltage inputs via the Config Table PCP object, subindexes 01_{hex} to 04_{hex} (see “Config Table, overview” on page 4-5).

Table 1-1 Configuration of current and voltage inputs

	Without transformer/ transducer	With current transformer	With current transformer and voltage transducer
Primary phase conductor voltage	0	0	100 ... 32767 [in V]
Secondary phase conductor voltage	0	0	1000 ... 7500 [in 0.1 V]
Primary phase current	0	1 ... 32767 [in A]	
Secondary phase current, 1 A/5 A measuring input switchover	1000/5000	150 ... 6000 [in mA]	

2 Operating modes

You can run the terminal in three operating modes:

– Basic measured values mode
– Scanning measured values mode
– Synchronization mode

2.1 Basic measured values mode

See Config Table PCP object 0080_{hex} subindex $0E_{hex}$

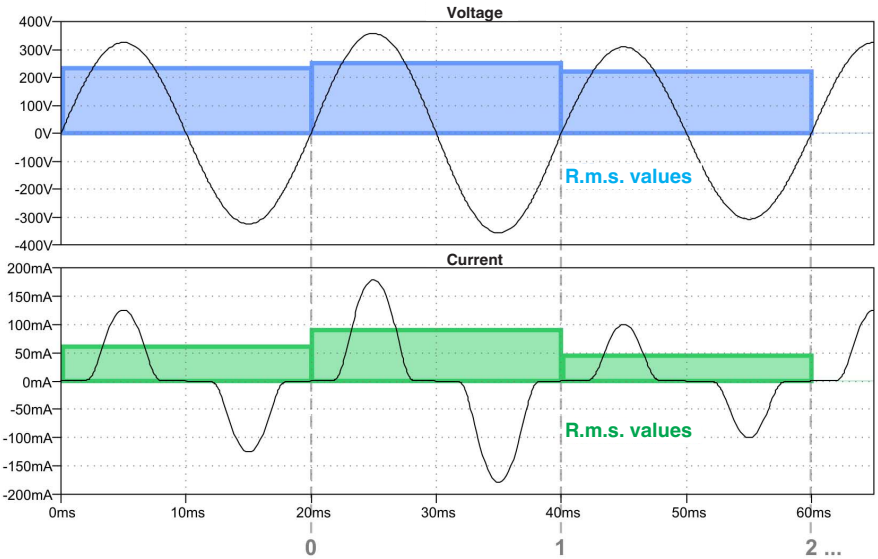

Figure 2-1 Basic measured values (not to scale)

2.1.1 Measured values

The terminal determines all measured values as root means square values per full wave.

More detailed information on all measured values such as dimension, access options or controllability can be found in Section “Objects with measured values, diagnostics, and control” on page 4-10.

Mains variables

– Phase voltages
– Phase conductor voltage
– Phase currents
– Neutral conductor current
– Real power values per phase and total
– Reactive power values per phase
– Apparent power values per phase and total
– Power factors per phase and total
– Frequency
– Power flow direction

The terminal can output these mains variables per full wave or via 2, 4, 8 or any multiple of 4 averaged full waves, i.e., the process data update time is 20/40/80/160/240/320/... ms at 50 Hz.

Current measurement with time response (bimetal filtering)

Filtered values are also available for the phase currents and the neutral conductor current. The filter characteristic corresponds to bimetal measuring devices with time settings from one to twenty minutes.

Power meter

Operating times for real and reactive power are counted separately for consumption and supply or for inductive and capacitive.

– Real energy, separate consumption and supply
– Reactive energy, separate inductive and capacitive
– S0 pulses
– Operating hours counter, if a current greater than 0.5% of the nominal value flows

Interval powers (triggers for measurement intervals can be freely defined)

Measurement intervals can be triggered at will for creating load profiles. The determined power values (real, reactive, and apparent power) of the elapsed interval are buffered ready for evaluation.

Harmonics analysis

FFT (Fast Fourier Transformation) is used to measure the r.m.s. values of both the fundamental waves and the harmonics of voltages and currents up to the 31st harmonic **once per second**.

The individual and overall harmonic distortion is then calculated from this.

Maximum values

Maximum values **by amount** are determined for most measured values.

2.1.2 Connection according to network type

2.1.2.1 Overview of the configuration of connection methods

The connection method parameter of the Config Table object is used to configure the connection method (see “Config Table, overview” on page 4-5).

Designation	Neutral conductor present	Use	Connection method code	Bit assignment in the connection method parameter of the Config Table object							
				7	6	5	4	3	2	1	0
Three-phase	No	Three-wire three-phase network with uneven load	00_{hex}	0		0	0	0	0		
		External two-wattmeter circuit									
I1 + L1-N	No	Three-wire three-phase network with even load, only phase 1 is measured (economy circuit)	04_{hex}	0		0	0	0	4		
I1 + L1-L3	No	Three-wire three-phase network with even load (economy circuit)	05_{hex}	0		0	0	0	5		
Three-phase	Yes	Four-wire three-phase network with uneven load	10_{hex}	0		0	1	0	0		
Open-Y	Yes	Four-wire three-phase network with uneven load, with just two voltage transducers (economy circuit)	12_{hex}	0		0	1	0	2		
I1 + L1-N	Yes	Four-wire three-phase network with even load, only phase 1 is measured (economy circuit)	14_{hex}	0		0	1	0	4		
AC current	Yes	Single-phase AC current	16_{hex}	0		0	1	0	6		
Split phase	Yes	Two-phase network	17_{hex}	0		0	1	0	7		
With neutral conductor current	Yes	On all networks which have a neutral conductor, the neutral conductor current can be measured additionally whatever the type of circuit.	$3x_{hex}$	0		1	1	0	x		

Bit 7, 6 Not relevant
Bit 5 = 0 Neutral conductor current not connected
Bit 5 = 1 Neutral conductor current connected
Bit 4 = 0 Neutral conductor not connected
Bit 4 = 1 Neutral conductor connected
Bit 3 Not relevant
Bit 2 ... 0 Type of circuit

2.1.2.2 Four-wire three-phase network with uneven load

Configuration:	Connection method = 10_{hex} or 30_{hex}
Connection:	Direct or with transformer/transducer
	With neutral conductor current (connection method = 30_{hex}) see Figure 2-2 to Figure 2-4, without neutral conductor current (connection method = 10_{hex}) accordingly.
Measured values:	For connection method = 10_{hex} the neutral conductor current is calculated approximately from the three phase currents.

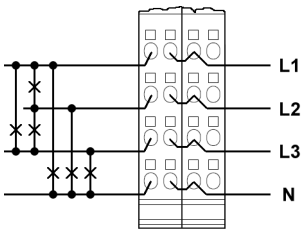

Figure 2-2 Four-wire three-phase network with uneven load

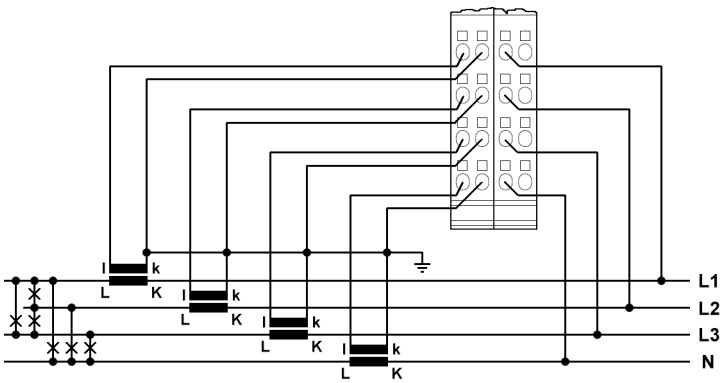

Figure 2-3 Four-wire three-phase network with uneven load

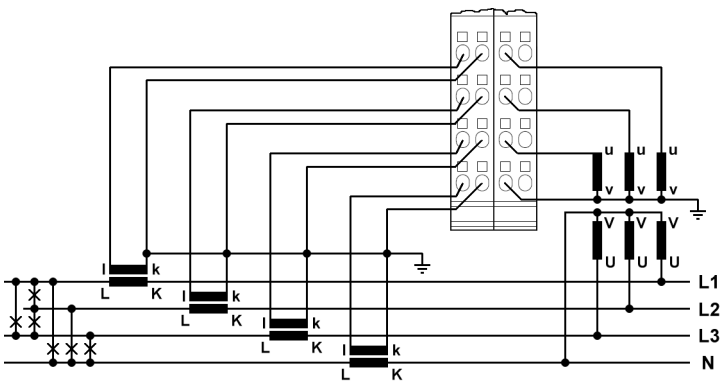

Figure 2-4 Four-wire three-phase network with uneven load

2.1.2.3 Four-wire three-phase network with uneven load (Open-Y economy circuit)

Eliminating: The voltage transducer for phase 2 is eliminated, this is useful particularly in high-voltage networks.

Configuration: Connection method = 12_{hex}

Connection: Only useful with transformer/transducer, see Figure 2-5

Measured values: The voltage of phase 2 is calculated from the two other voltages, which means that the neutral conductor and the calculated star point must coincide.

The neutral conductor current is calculated approximately from the three phase currents; it can also be measured (connection method = 32_{hex}).

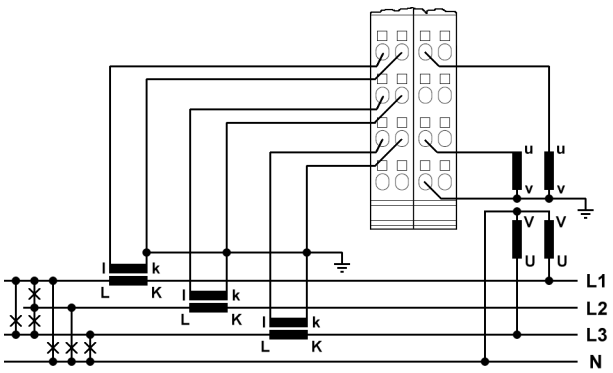

Figure 2-5 Four-wire three-phase network with uneven load (Open-Y economy circuit)

2.1.2.4 Four-wire three-phase network with even load (I1 + L1-N)

Eliminating: If the voltages and currents are symmetrical, only one phase has to be measured.

The number of transformers/transducers is reduced by a third.

Configuration: Connection method = 14_{hex}

Connection: Direct or with transformer/transducer, see Figure 2-6

Measured values: Only phase 1 is measured, the total values are calculated from phase 1.

2.1.2.5 Single-phase AC current

Configuration: Connection method = 14_{hex}

Connection: Direct or with transformer/transducer, see Figure 2-6

Measured values: Only phase 1 is measured.

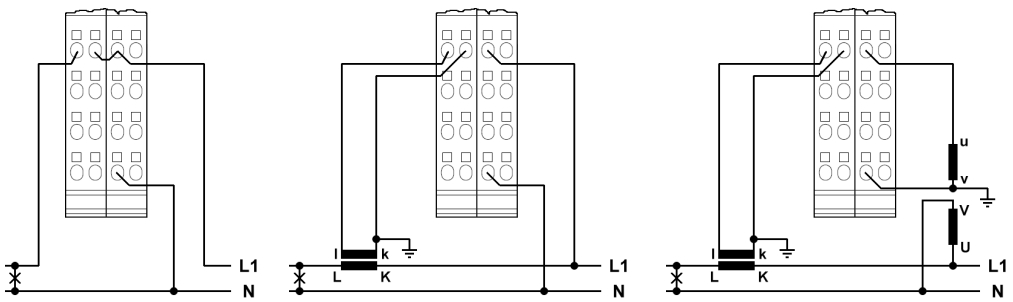

Figure 2-6 Single-phase AC current

2.1.2.6 Three-wire three-phase network with uneven load

Configuration: Connection method = 00_{hex}

Connection: Direct or with transformer/transducer, see Figure 2-7

Measured values: The ground current (neutral conductor current operand) is calculated approximately from the three phase currents.

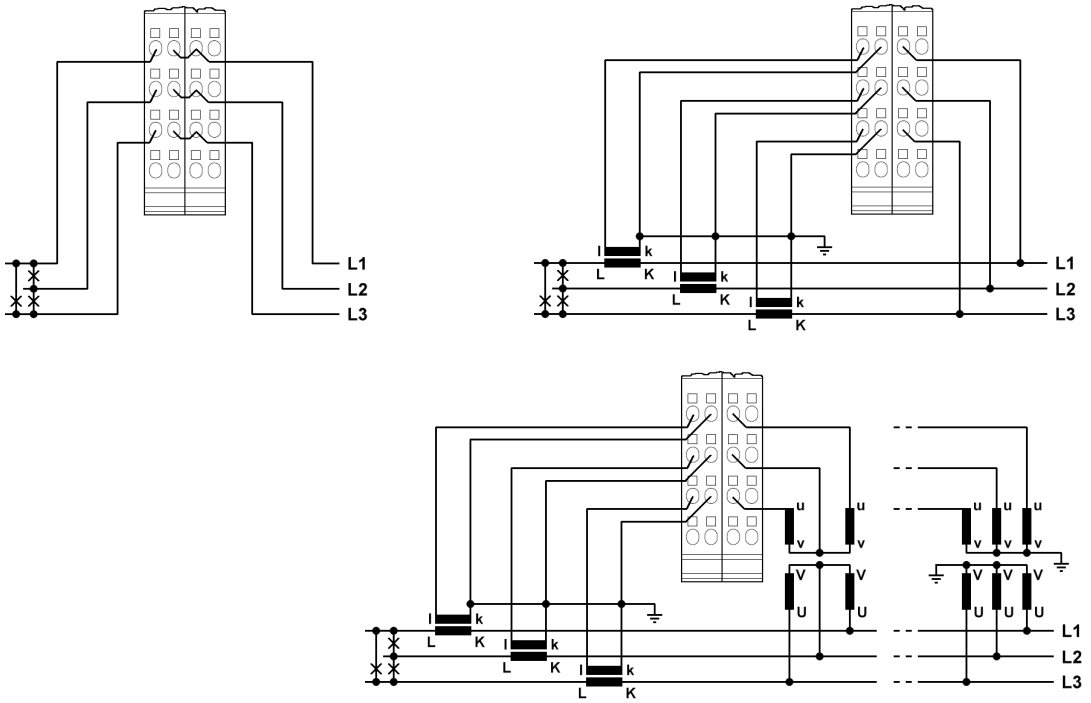

Figure 2-7 Three-wire three-phase network with uneven load

2.1.2.7 Three-wire three-phase network with uneven load (external two-wattmeter circuit)

Configuration: Connection method = 00_{hex}

Connection: Only possible with transformer/transducer, see Figure 2-8.
For voltage transducer connection, see also Figure 2-7.

Measured values: The ground current (neutral conductor current operand) is calculated approximately from the three phase currents.

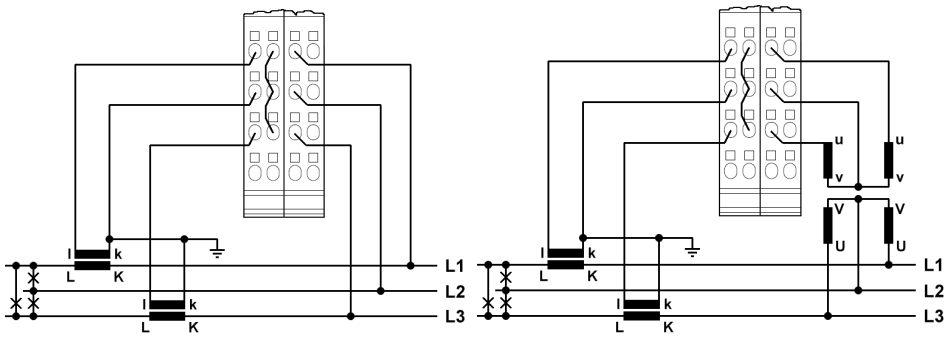

Figure 2-8 Three-wire three-phase network with uneven load (external two-wattmeter circuit)

2.1.2.8 Three-wire three-phase network with even load (I1 + L1-N)

Eliminating: If the voltages and currents are symmetrical, only one phase has to be measured.

Only one current transformer required.

Configuration: Connection method = 04_{hex}

Connection: Only useful with transformer/transducer, see Figure 2-9.
For voltage transducer connection, see also Figure 2-7.

Measured values: Only phase 1 is measured, the total values are calculated from phase 1.

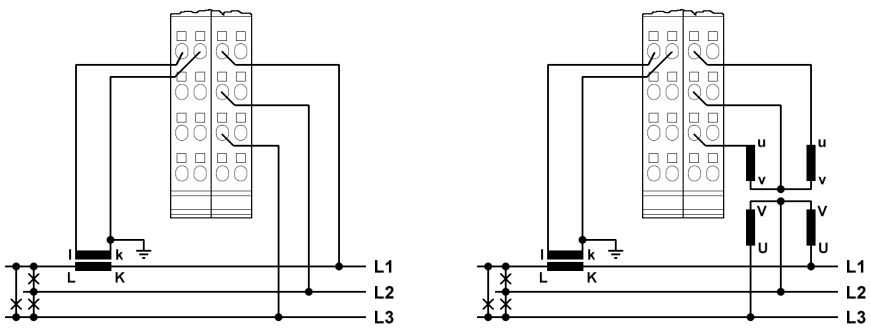

Figure 2-9 Three-wire three-phase network with even load (I1 + L1-N)

2.1.2.9 Three-wire three-phase network with even load (economy circuit I1 + L1-L3)

Eliminating: If the voltages and currents are symmetrical, the mains variables can be calculated from one current and one phase conductor voltage.

The number of transformers/transducers is reduced to a minimum.

Configuration: Connection method = 05_{hex}

Connection: Only useful with transformer/transducer, see Figure 2-10

Measured values: The total values are calculated from the current and the phase conductor voltage.

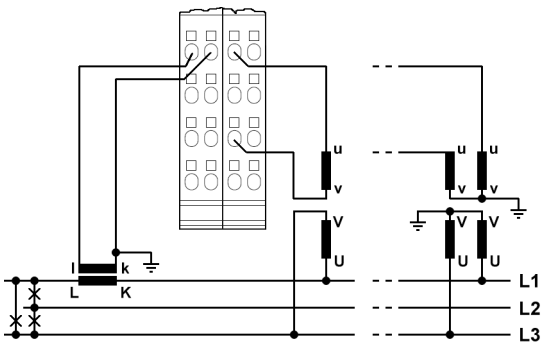

Figure 2-10 Three-wire three-phase network with even load (economy circuit I1 + L1-L3)

2.1.2.10 Two-phase network (split phase)

Configuration: Connection method = 13_{hex} or 33_{hex}

Connection: Direct or with transformer/transducer, see Figure 2-11

Measured values: Phase 3 is not measured.

For connection method = 13_{hex} the neutral conductor current is calculated approximately from the two phase currents.

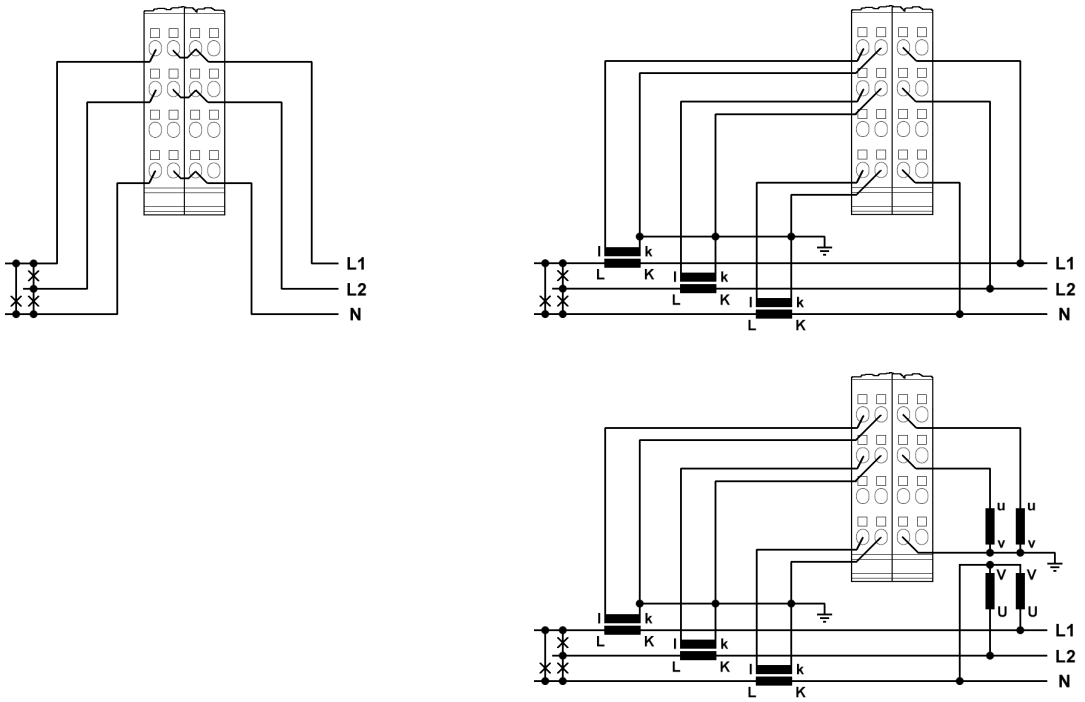

Figure 2-11 Two-phase network (split phase)

2.1.3 Calculating the reactive power and power factors

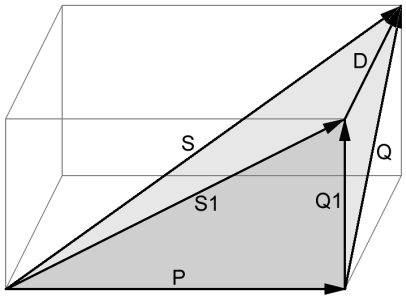

Figure 2-12 Reactive power and power factors

Key:

P:	Real power
S:	Apparent power taking harmonics into account
S1:	Fundamental apparent power
Q:	Total reactive power
Q1:	Fundamental reactive power
D:	Distortion reactive power

The majority of loads take an ohmic/inductive load current from the network. Reactive power is produced by the inductive load. However, increasing numbers of non-linear loads are also being connected. These include speed-controlled drives, rectifiers, thyristor controllers or fluorescent lamps. They cause non-sinusoidal alternating currents, which can be represented as the sum of harmonics. This increases the reactive power to be transmitted, which leads to higher transmission losses and current costs. This reactive power part is known as distortion reactive power.

In general, reactive power is not desirable as it does not provide a useable effective component. Since the transfer of reactive power over large distances is not economical, compensation systems are installed close to loads. This enables the better use of transmission capacities and avoids losses and voltage drops due to reactive currents.

The reactive power can be divided into a fundamental wave component (object 0083_{hex}) and a distortion component (object 0086_{hex}). Only the fundamental wave reactive power can be compensated directly using the conventional capacitive method. The distortion component must be treated with choking or active filters. Object 0086_{hex} also includes the total reactive power (calculated according to the standard), which has technically less significance.

The power factor (object 0083_{hex}) corresponds to the ratio of real power P to apparent power S, and therefore also includes any harmonics. This factor is often incorrectly referred to as cos(phi). However, the power factor only corresponds to cos(phi) if there are no harmonics in the network.

The cos(phi) value (object 0086_{hex}) represents the ratio of real power P to fundamental apparent power S1.

2.2 Scanning values mode

See Config Table PCP object 0080_{hex} subindex $0E_{hex}$

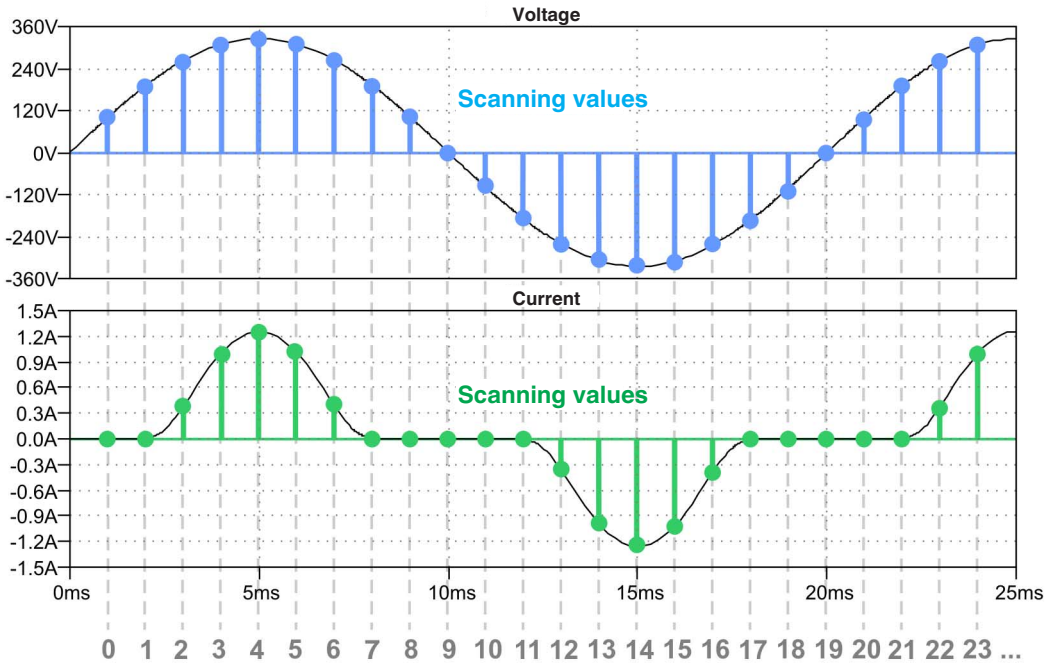

Figure 2-13 Scanning values (not to scale)

Scanning measured values are the instantaneous values of current and voltage according to phase, and of neutral conductor current and instantaneous real powers according to phase. Scanning measured values serve to acquire rapid changes in current, voltage peaks or dips, etc.

10 scanning values for each signal (u1 ... u3, i1 ... i3, i_{PEN}, or p1 ... p3), and a counter for the correct assignment of scanning values are transmitted via the process data.

Internal scanning involves 64 or 32 scans per full wave, and can be set with the averaging time.

The evaluation cycle for this operating mode must be faster than 3 or 6 ms at 50 Hz so that no values are lost.

Mains variables, such as reactive power, apparent power, power factor, r.m.s. values of current and voltage, etc., do not exist in this operating mode, since mains variables are not scanning values.

From Config Table PCP object 0080_{hex}, only subindexes 01_{hex} to 08_{hex} and $0D_{hex}$ are used.

2.3 Synchronization mode

Synchronization mode provides measured values which can be used to control the voltage, speed, and phase angle of a generator, so that it can be connected to the mains.

– Measurement is the same as for basic measured values.
– The measured values are output per full wave.
– One phase voltage each from the mains and generator, the phase angle between both voltages, and the frequency difference and mains frequency are measured.
– The currents are measured independently.

Connection for synchronization mode

– The phase voltage from the mains side must be connected to U1 and the associated phase voltage from the generator to U2, since the frequency and phase angle are only measured for these two connections.
– The measurement is frequency synchronous to connection U1.
– If the generator has no neutral conductor, generate a virtual one. Alternatively, connect two associated phase conductor voltages via identical transformers, which are secondary grounded.
– The free current inputs and connection U3 can be used to measure further values, preferably on the mains side because the measurement is mains synchronous and not generator synchronous.
– Set the connection method depending on the neutral conductor used to 10_{hex} or 30_{hex}.

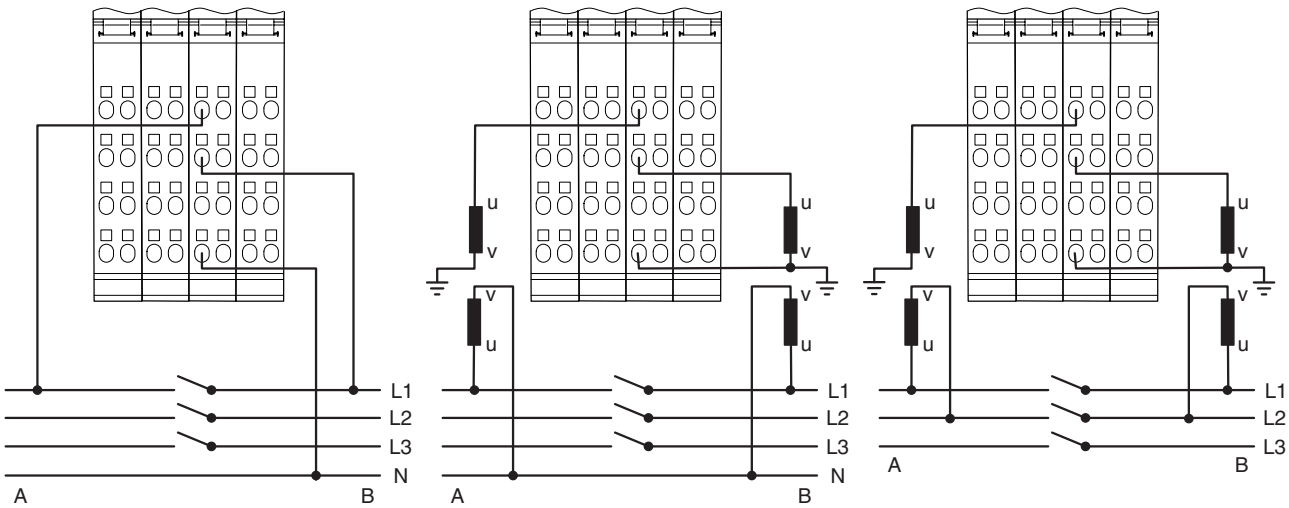

Figure 2-14 Connection for synchronization mode

A Mains
B Generator

3 Data transmission via process data

The width of the process data channel is twelve words (0 ... 11), which includes one control or status word and eleven data words.

The process data records are consistent along their entire length; they are mapped in full in IN0 to IN11.

If a process data record is shorter than twelve words, it is returned left-aligned and with zeros added.

Length code: $14_{dec}/0E_{hex}$

ID code: $220_{dec}/DC_{hex}$

3.1 OUT process data

The contents of the IN process data can be selected via the control word. This means that data acquisition can be implemented to log the data (fast enough).

The contents of the IN process data for control words 0100_{hex} ... $0C00_{hex}$ are identical to the contents of PCP objects 0081_{hex} ... $008C_{hex}$ (see Table 3-1).

3.1.1 Control word OUT0

15 ... 8	7 ... 0
Command code	0 ... 0

The low byte of control word OUT0 is always zero.

Table 3-1 Relationship between control word OUT0 and PCP objects

OUT0 (bits 15 to 0)	Function	Mode
0100_{hex}	Read object 0081_{hex} (display in IN1 ... IN11)	B
0200_{hex}	Read object 0082_{hex} (display in IN1 ... IN10)	B
0300_{hex}	Read object 0083_{hex} (display in IN1 ... IN11)	B
0400_{hex}	Read object 0084_{hex} (display in IN1 ... IN10)	B
0500_{hex}	Read object 0085_{hex} (display in IN1 ... IN9)	B
0600_{hex}	Read object 0086_{hex} (display in IN1 ... IN10)	B
0700_{hex}	Read object 0087_{hex} (display in IN1 ... IN7)	S
0800_{hex}	Read object 0088_{hex} (display in IN1 ... IN11)	B
$0C00_{hex}$	Read and write object $008C_{hex}$ (short-time control) (display in IN1 and output in OUT1)	B
1100_{hex}	Read scanning values of phase voltage u1(t)	A
1200_{hex}	Read scanning values of phase voltage u2(t)	A
1300_{hex}	Read scanning values of phase voltage u3(t)	A

Table 3-1 Relationship between control word OUT0 and PCP objects

OUT0 (bits 15 to 0)	Function	Mode
1400_{hex}	Read scanning values of conductor current i1(t)	A
1500_{hex}	Read scanning values of conductor current i2(t)	A
1600_{hex}	Read scanning values of conductor current i3(t)	A
1700_{hex}	Read scanning values of neutral conductor current iPEN(t)	A
1800_{hex}	Read scanning values of real power p1(t)	A
1900_{hex}	Read scanning values of real power p2(t)	A
$1A00_{hex}$	Read scanning values of real power p3(t)	A
$1D00_{hex}$	Read diagnostic word (display in IN1)	All
$3C00_{hex}$	Read firmware version and module ID (display in IN1)	All

Operating modes:

A Scanning values

B Basic measured values

S Synchronization

3.1.2 OUT1 to OUT11

Data words OUT1 to OUT11 are only evaluated for control word $0C00_{hex}$. In this case, data word OUT1 contains the commands for short-time control.

OUT1 to OUT11 are not evaluated for any other codes in control word OUT0. For reasons of compatibility, set the words to 0.

3.1.3 Short-time control (control word $0C00_{hex}$)

Some operations in the terminal have to be triggered in realtime. They include:

– Freezing or resetting the power meter in order to acquire the energy consumption in an installation by production unit, for example
– Triggering power intervals in order to create a load profile
– Resetting maximum values
– Acknowledging completion or a state

This can be done via process data (control word $0C00_{hex}$) or, in the case of non-time-critical operations, via PCP (object index $008C_{hex}$).

Command word in OUT1 (for control word $0C00_{hex}$)

Table 3-2 Command word OUT1 (for control word $0C00_{hex}$)

Bit	Action	Meaning	Objects affected
0	= 1	Freeze meter readings (energy)	0084_{hex}
1	0 -> 1	Reset meter readings (energy)	0084_{hex}
2		–	
3	0 -> 1	Trigger power intervals	0085_{hex}
4	0 -> 1	Reset maximum values for power intervals	0085_{hex}
5		–	
6	0 -> 1	Reset maximum values for currents, voltages, powers	0091_{hex} ... 0093_{hex}
7		–	
8	0 -> 1	Reset maximum values for harmonics analysis	$00B0_{hex}$ ... $00B7_{hex}$
9		–	
10	0 -> 1	Reset operating hours	0084_{hex}
11		–	
12		–	
13		–	
14		–	
15	= 1	Suppress error messages	Diagnostic word Bits 0 ... 6

3.2 IN process data words

3.2.1 Status word IN0

15 ... 8	7 ... 0
EB	Mirrored command code	Input error

EB: error bit

0 No error has occurred.

1 An error has occurred.

Input errors

If all bits are set simultaneously, all measured values are invalid, e.g., due to a hardware fault.

For the meaning of the bits, see Table 3-3.

Table 3-3 Input errors

Bit	Meaning
0	Current input phase 1 overloaded
1	Current input phase 2 overloaded
2	Current input phase 3 overloaded
3	Current input neutral conductor overloaded
4	Voltage input phase 1 overloaded
5	Voltage input phase 2 overloaded
6	Voltage input phase 3 overloaded
7	Changes (toggles) when the diagnostic word changes AND the diagnostic word has been retrieved (control word = $1D00_{hex}$)

3.2.2 IN process data words IN0 to IN11

For a detailed description, see the relevant PCP objects.

3.2.2.1 Input data for basic measured values mode

Control word 0100_{hex} (see object 0081_{hex})		
IN0	WORD	Status word
IN1	INT	Phase voltage 1
IN2	INT	Phase voltage 2
IN3	INT	Phase voltage 3
IN4	INT	Phase current 1
IN5	INT	Phase current 2
IN6	INT	Phase current 3
IN7	INT	Neutral conductor current
IN8	INT	Real power 1
IN9	INT	Real power 2
IN10	INT	Real power 3
IN11	INT	Total real power

Control word 0200_{hex} (see object 0082_{hex})		
IN0	WORD	Status word
IN1	INT	Phase conductor voltage 12
IN2	INT	Phase conductor voltage 23
IN3	INT	Phase conductor voltage 31
IN4	INT	Phase current 1 “bimetal filtering”
IN5	INT	Phase current 2 “bimetal filtering”
IN6	INT	Phase current 3 “bimetal filtering”
IN7	INT	Neutral conductor current “bimetal filtering”
IN8	INT	Frequency
IN9	WORD	Energy direction
IN10	WORD	S0 pulses
IN11	INT	0

Control word 0300_{hex} (see object 0083_{hex})		
IN0	WORD	Status word
IN1	INT	Reactive power 1
IN2	INT	Reactive power 2
IN3	INT	Reactive power 3
IN4	INT	Apparent power 1
IN5	INT	Apparent power 2
IN6	INT	Apparent power 3
IN7	INT	Total apparent power
IN8	INT	Power factor 1
IN9	INT	Power factor 2
IN10	INT	Power factor 3
IN11	INT	Power factor total

Control word 0400_{hex} (see object 0084_{hex})		
IN0	WORD	Status word
IN1	DINT	Real energy consumption (bit 31 ... 16)
IN2		Real energy consumption (bit 15 ... 0)
IN3	DINT	Real energy supply (bit 31 ... 16)
IN4		Real energy supply (bit 15 ... 0)
IN5	DINT	Reactive energy inductive (bit 31 ... 16)
IN6		Reactive energy inductive (bit 15 ... 0)
IN7	DINT	Reactive energy capacitive (bit 31 ... 16)
IN8		Reactive energy capacitive (bit 15 ... 0)
IN9	UDINT	Operating hours (bit 31 ... 16)
IN10		Operating hours (bit 15 ... 0)
IN11	INT	0

Control word 0500_{hex} (see object 0085_{hex})		
IN0	WORD	Status word
IN1	INT	Current interval real power
IN2	INT	Elapsed interval real power
IN3	INT	Maximum interval real power [1)]
IN4	INT	Current interval reactive power
IN5	INT	Elapsed interval reactive power
IN6	INT	Maximum interval reactive power [1)]
IN7	INT	Current interval apparent power
IN8	INT	Elapsed interval apparent power
IN9	INT	Maximum interval apparent power
IN10	INT	0
IN11	INT	0

[1)] Maximum by amount

Control word 0600_{hex} (see object 0086_{hex})		
IN0	WORD	Status word
IN1	INT	Distortion reactive power 1
IN2	INT	Distortion reactive power 2
IN3	INT	Distortion reactive power 3
IN4	INT	Reactive power 1 (according to standard)
IN5	INT	Reactive power 2 (according to standard)
IN6	INT	Reactive power 3 (according to standard)
IN7	INT	Total reactive power (according to standard)
IN8	INT	cos(phi) 1
IN9	INT	cos(phi) 2
IN10	INT	cos(phi) 3
IN11	INT	0

Control word 0700_{hex} (see object 0087_{hex})		
IN0	WORD	Status word
IN1	INT	Phase voltage 1
IN2	INT	Phase voltage 2
IN3	INT	Phase voltage 3
IN4	INT	Angle phase 2 - phase 1
IN5	INT	Angle phase 2 - phase 1 for PLL
IN6	INT	Frequency phase 1
IN7	INT	Frequency difference phase 2 - phase 1
IN8	INT	0
IN9	INT	0
IN10	INT	0
IN11	INT	0

Control word 0800_{hex} (see object 0088_{hex})		
IN0	WORD	Status word
IN1	INT	1st data sample “reference”
IN2	INT	2nd data sample “reference”
IN3	INT	...to (maximum)…
IN4	INT	
IN5	INT	
IN6	INT	
IN7	INT	
IN8	INT	
IN9	INT	
IN10	INT	
IN11	INT	11th data sample “reference” (the composition of the process data is determined by the length, number, and type of referenced objects in object 0088_{hex})

Control word $0C00_{hex}$		
IN0	WORD	Status word
IN1	INT	Mirrored command word (see “Command word in OUT1 (for control word 0C00hex)” on page 3-3)
IN2 ... IN11	INT	0

3.2.2.2 Input data for scanning values mode

The dimensions of the scanning values are the same as those of the r.m.s. values in object 0081_{hex}.

Control word 1100_{hex}		
IN0	WORD	Status word
IN1	INT	Scanning value voltage u1(t0 - 9 x Δt)
IN2	INT	Scanning value voltage u1(t0 - 8 x Δt)
IN3	INT	...
IN4	INT	...
IN5	INT	...
IN6	INT	...
IN7	INT	...
IN8	INT	...
IN9	INT	Scanning value voltage u1(t0 - 1 x Δt)
IN10	INT	Scanning value voltage u1(t0)
IN11	UINT	Scanning meter reading for t0

Δt = 1/64 or 1/32 of the mains period

Control word 1200_{hex}		
IN0	WORD	Status word
IN1	INT	Scanning value voltage u2(t0 - 9 x Δt)
IN2	INT	Scanning value voltage u2(t0 - 8 x Δt)
IN3	INT	...
IN4	INT	...
IN5	INT	...
IN6	INT	...
IN7	INT	...
IN8	INT	...
IN9	INT	Scanning value voltage u2(t0 - 1 x Δt)
IN10	INT	Scanning value voltage u2(t0)
IN11	UINT	Scanning meter reading for t0

Control word 1300_{hex}		
IN0	WORD	Status word
IN1	INT	Scanning value voltage u3(t0 - 9 x Δt)
IN2	INT	Scanning value voltage u3(t0 - 8 x Δt)
IN3	INT	...
IN4	INT	...
IN5	INT	...
IN6	INT	...
IN7	INT	...
IN8	INT	...
IN9	INT	Scanning value voltage u3(t0 - 1 x Δt)
IN10	INT	Scanning value voltage u3(t0)
IN11	UINT	Scanning meter reading for t0

Control word 1400_{hex}		
IN0	WORD	Status word
IN1	INT	Scanning value current i1(t0 - 9 x Δt)
IN2	INT	Scanning value current i1(t0 - 8 x Δt)
IN3	INT	...
IN4	INT	...
IN5	INT	...
IN6	INT	...
IN7	INT	...
IN8	INT	...
IN9	INT	Scanning value current i1(t0 - 1 x Δt)
IN10	INT	Scanning value current i1(t0)
IN11	UINT	Scanning meter reading for t0

Control word 1500_{hex}		
IN0	WORD	Status word
IN1	INT	Scanning value current i2(t0 - 9 x Δt)
IN2	INT	Scanning value current i2(t0 - 8 x Δt)
IN3	INT	...
IN4	INT	...
IN5	INT	...
IN6	INT	...
IN7	INT	...
IN8	INT	...
IN9	INT	Scanning value current i2(t0 - 1 x Δt)
IN10	INT	Scanning value current i2(t0)
IN11	UINT	Scanning meter reading for t0

Control word 1600_{hex}		
IN0	WORD	Status word
IN1	INT	Scanning value current i3(t0 - 9 x Δt)
IN2	INT	Scanning value current i3(t0 - 8 x Δt)
IN3	INT	...
IN4	INT	...
IN5	INT	...
IN6	INT	...
IN7	INT	...
IN8	INT	...
IN9	INT	Scanning value current i3(t0 - 1 x Δt)
IN10	INT	Scanning value current i3(t0)
IN11	UINT	Scanning meter reading for t0

Control word 1700_{hex}		
IN0	WORD	Status word
IN1	INT	Scanning value current iPEN(t0 - 9 x Δt)
IN2	INT	Scanning value current iPEN(t0 - 8 x Δt)
IN3	INT	...
IN4	INT	...
IN5	INT	...
IN6	INT	...
IN7	INT	...
IN8	INT	...
IN9	INT	Scanning value current iPEN(t0 - 1 x Δt)
IN10	INT	Scanning value current iPEN(t0)
IN11	UINT	Scanning meter reading for t0

Control word 1800_{hex}		
IN0	WORD	Status word
IN1	INT	Scanning value real power p1(t0 - 9 x Δt)
IN2	INT	Scanning value real power p1(t0 - 8 x Δt)
IN3	INT	...
IN4	INT	...
IN5	INT	...
IN6	INT	...
IN7	INT	...
IN8	INT	...
IN9	INT	Scanning value real power p1(t0 - 1 x Δt)
IN10	INT	Scanning value real power p1(t0)
IN11	UINT	Scanning meter reading for t0

Control word 1900_{hex}		
IN0	WORD	Status word
IN1	INT	Scanning value real power p2(t0 - 9 x Δt)
IN2	INT	Scanning value real power p2(t0 - 8 x Δt)
IN3	INT	...
IN4	INT	...
IN5	INT	...
IN6	INT	...
IN7	INT	...
IN8	INT	...
IN9	INT	Scanning value real power p2(t0 - 1 x Δt)
IN10	INT	Scanning value real power p2(t0)
IN11	UINT	Scanning meter reading for t0

Control word $1A00_{hex}$		
IN0	WORD	Status word
IN1	INT	Scanning value real power p3(t0 - 9 x Δt)
IN2	INT	Scanning value real power p3(t0 - 8 x Δt)
IN3	INT	...
IN4	INT	...
IN5	INT	...
IN6	INT	...
IN7	INT	...
IN8	INT	...
IN9	INT	Scanning value real power p3(t0 - 1 x Δt)
IN10	INT	Scanning value real power p3(t0)
IN11	UINT	Scanning meter reading for t0

3.2.2.3 Input data for all operating modes

Control word $1D00_{hex}$		
IN0	WORD	Status word
IN1	INT	Diagnostic word (see “Diagnostic word in IN1 (control word 1D00hex)” on page 3-15)
IN2 ... IN11	INT	0

Control word $3C00_{hex}$		
IN0	WORD	Status word
IN1	INT	Firmware version and module ID
IN2 ... IN11	INT	0

3.2.3 Diagnostic word in IN1 (control word $1D00_{hex}$)

Table 3-4 Diagnostic word in IN1 (control word $1D00_{hex}$)

Bit	Meaning	Remark
0	No frequency synchronization	Can be suppressed
1	Frequency < 40 Hz	
2	Frequency > 70 Hz	
3	–	
4	Direction of rotation incorrect	
5	No direction of rotation found	
6	Phase failure	
7	Terminal not calibrated	Cannot be suppressed
8	–	
9	–	
10	–	
11	Transformer/transducer factors invalid	
12	Invalid configuration	
13	–	
14	Terminal faulty	
15	–	

3.2.4 Firmware and module ID in IN1 (control word $3C00_{hex}$)

Table 3-5 Firmware and module ID in IN1 (control word $3C00_{hex}$)

	Firmware version (e.g., 1.21)												Module ID = 3			
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Value	0	0	0	1	0	0	1	0	0	0	0	1	0	0	1	1

4 PCP

The width of the parameter channel is two words.

4.1 Standard objects

Table 4-1 Standard objects

Index [hex]	Object	Data type	Access	Contents/function
0001	ManufacturerName VendorName	String	R	“Phoenix Contact GmbH & Co. KG / GMC-I Messtechnik GmbH”
0002	ManufacturerID VendorID	String	R	“00A045”
0004	DeviceRange DeviceFamily	String	R	“I/O function terminal”
0006	ProductRange ProductFamily	String	R	“Inline”
0007	ProductName	String	R	“IB IL PM 3P/N/EF-PAC”
0009	ProductText	String	R	“Power measurement”
000A	OrderNumber	String	R	“2700965”
000B .1 .2	HardwareVersion HWVersion_BuildDate HWVersion_Identifier	Record String String	R	 “YYYY-MM-DD” “HW V1.00”
000C .1 .2	FirmwareVersion FWVersion_BuildDate FWVersion_Identifier	Record String String	R	 “YYYY-MM-DD” “FW V1.00”
000D .1 .2	PCPVersion PCPVersion_BuildDate PCPVersion_Identifier	Record String String	R	 “2002-09-12” “Compact-PCP V1.00”
000E	CommunicationProfile CommProfile	String	R	 “663”
000F	DeviceProfile	U16	R	0010
0011 .1 .2	ProfileVersion ProfileVersion_BuildDate ProfileVersion_Identifier	Record String String	R	 “2006-06-19” “Basic Profile V1.10”
0012	VendorURL	String	R	“http://www.phoenixcontact.com ; www.gossenmetrawatt.com”
0017 .1 .2	Language LanguageCode LanguageText	Record String String	R	 “en” “English”

Table 4-1 Standard objects

Index [hex]	Object	Data type	Access	Contents/function
0018	DiagState	Record	R	Current diagnostic state of the device
.1	Seq.no.	U16		Error number since reset or restart
.2	Priority	U8		Priority of the message (“1” is the highest priority) (1 = error, 2 = warning, 3 = message)
.3	Channel	U8		Channel on which the error occurred. Channel “FF” refers to the entire device
.4	Code	O16		Error code (see Section ___)
.5	MoreFollows	U8		00 hex = no further information
.6	Text	String[]		Message text, default: “Status OK” (maximum 50 characters)
0019	ResetDiag	U8	W	Deletes the corresponding diagnostic memory of the device. 01_{hex}: Not implemented (This object is only supported when the “DiagHistory(Long)” object exists, it normally deletes the entire diagnostic history.) 02_{hex}: Deletes all pending DiagStates (errors) that have not been read out. 03_{hex}: Deletes the entire diagnostics Else: Invalid
001A	GetErrorRep	U8	R/W	Enables the generation of an information report using the contents of the “DiagState” object in the event of an error. 0: Disables the generation of an information report. <>0: Enables the generation of an information report. Default: 0 (GetErrorRep off)
0025	PDIN	16 bits	R	IN process data
0026	PDOUT	16 bits	R/W	OUT process data
0027	GetExRight	8 bits	R/W	Request exclusive write access Specifies which communication channel (process data or PCP) is assigned exclusive write access. 0: Output data is used from the process data channel <>0: Output data is set via PCP object 0026_{hex}: PDOUT. Default: 0 (output data via process data channel) **NOTE:** This action may have serious consequences for the connected process. With each module reset, each INTERBUS reset, and each process data timeout, the object is reset (OUTProcessData_Enable = “0”).

Table 4-1 Standard objects

Index [hex]	Object	Data type	Access	Contents/function
002D	ResetParam	8 bits	W	01_{hex}: Reset parameterization This command is used to undo all settings and replace them with (factory) default values. This also applies to passwords and other user-defined settings (see Config Table object).
0032	IBS_ID	Record	R	INTERBUS identification
.1		U8		INTERBUS ID code
.2		U16		INTERBUS process data bits

R/W Read and write permitted

R Read only

W Write only

4.2 Application objects, overview

The following objects are defined for basic measured values mode.

Maximum values in the objects are mapped by amount.

For scanning measured values mode, there are only the Config Table objects (0080_{hex}), where not all subindexes are relevant, and diagnostics ($009D_{hex}$).

Table 4-2 Application objects

Index [hex]	Object name	Meaning	Data type	N	L	Rights
0080	Config Table [1])	Configuration	Record	1	22	R/W
0081	Basic Values	Voltages, currents, real powers	Array of INT	11	2	R
0082	Ext. Values	Phase conductor voltages, bimetal current measurement, frequency, energy direction, S0 pulses	Array of INT	10	2	R
0083	Power	Reactive and apparent powers, power factors	Array of INT	11	2	R
0084	Energy	Energies	Array of DINT	5	4	R/W
0085	Interval Power	Interval powers	Array of INT	9	2	R
0086	Reactive Power	Reactive power, cos(phi)	Array of INT	10	2	R
0087	Synchronization	Values for synchronization	Array of INT	7	2	R
0088	Data Sample	Configurable process data record	Array of Record	11	4	R/W
008C	Short-time Control	Control of energies, intervals, and maximum values	WORD	1	2	R/W
0091	Max. Basic Values	Voltages, currents, real powers	Array of INT	11	2	R

Table 4-2 Application objects

Index [hex]	Object name	Meaning	Data type	N	L	Rights
0092	Max. Ext. Values	Phase conductor voltages, bimetal current measurement	Array of INT	7	2	R
0093	Max. Power	Reactive and apparent powers, power factors	Array of INT	11	2	R
0096	Max. Reactive Power	Reactive power, cos(phi)	Array of INT	10	2	R
009D	PD Diag State	Diagnostic bits	Record	1	3	R
00A0	Total Harm. Dist.	Distortion factors	Array of INT	7	2	R
00A1	Harm. Dist. U1	1st to 31st harm. distortion U1	Array of INT	31	2	R
00A2	Harm. Dist. U2	1st to 31st harm. distortion U2	Array of INT	31	2	R
00A3	Harm. Dist. U3	1st to 31st harm. distortion U3	Array of INT	31	2	R
00A4	Harmonics I1	1st to 31st harmonics I1	Array of INT	31	2	R
00A5	Harmonics I2	1st to 31st harmonics I2	Array of INT	31	2	R
00A6	Harmonics I3	1st to 31st harmonics I3	Array of INT	31	2	R
00A7	Harmonics IN	1st to 31st harmonics IN	Array of INT	31	2	R
00B0	Max. THD	Distortion factors	Array of INT	7	2	R
00B1	Max. HD U1	1st to 31st harm. distortion U1	Array of INT	31	2	R
00B2	Max. HD U2	1st to 31st harm. distortion U2	Array of INT	31	2	R
00B3	Max. HD U3	1st to 31st harm. distortion U3	Array of INT	31	2	R
00B4	Max. Harmonics I1	1st to 31st harmonics I1	Array of INT	31	2	R
00B5	Max. Harmonics I2	1st to 31st harmonics I2	Array of INT	31	2	R
00B6	Max. Harmonics I3	1st to 31st harmonics I3	Array of INT	31	2	R
00B7	Max. Harmonics IN	1st to 31st harmonics IN	Array of INT	31	2	R

[1]): Stored with mains failure protection

N: Number of elements

L: Length of an element in bytes

R/W: Read and write permitted

R: Read only

4.3 Terminal parameterization

The default values are shown in bold in the following tables.

4.3.1 Config Table, overview

The Config Table contains all settings for terminal parameterization

Table 4-3 0080_{hex}: Config Table

Object	Config Table					
Access	Read/write					
Data	Terminal configuration					
Data type	Record			22 bytes		
$Index_{hex}$	0080					Default
Subindex [hex]	00	Record	Read/write all elements			
	01	INT	Primary phase conductor voltage	prim.U = **0**, 100 ... 32767 [in V]	1)	0
	02	INT	Secondary phase conductor voltage	sec.U = **0**, 1000 ... 7500 [in 0.1 V]	1)	0
	03	INT	Primary phase current	prim.I = **0**, 1 ... 32767 [in A]	1)	0
	04	INT	Secondary phase current, measuring range switchover	sec.I = 150 ... **5000** ... 6000 [in mA]	1)	5000
	05	SINT	Dimension voltage	Dim.U = tens exponent referencing V	2)	–
	06	SINT	Dimension current	Dim.I = tens exponent referencing A	2)	–
	07	SINT	Dimension power	Dim.P = tens exponent referencing W, VA	2)	–
	08	SINT	Dimension energy	Dim.E = tens exponent referencing Wh, VArh	2)	–
	09	BYTE	S0 pulse source	See page 4-7	B)	00_{hex}
	0A	BYTE	Connection method	See page 4-8	B)	30_{hex}
	0B	BYTE	Reactive power display	See page 4-8	B)	00_{hex}
	0C	BYTE	Frequency synchronization	See page 4-9		00_{hex}
	0D	INT	Averaging time	0 ... 32767 [in ms]; see page 4-9		160
	0E	USINT	Operating mode (measuring mode)	0 Basic measured values 1 Scanning values 2 Reserved 3 Synchronization 4 ... 255 Not used		0
	0F	USINT	Time setting for bimetal filtering	1 ... **10** ... 20 [in minutes]	B)	10
	10	INT	Reserved	0		0

1) Default values mean direct connection without transformer/transducer.

2) Written value is not used in this firmware version. Set it to 0.
The dimensions of the measured values are calculated from the transformer/transducer data, see Section 4.3.3.

B) Settings are only effective in basic measured values mode.

4.3.2 Configuration of current and voltage inputs

Ssubindexes 01_{hex} ... 04_{hex}

See also “Configuration of current and voltage inputs” on page 1-4.

When using current transformers or voltage transducers that can be operated well under their nominal value, the display of measured values may lose resolution, i.e., the dimensions will be larger than necessary.

In this case it may be helpful to enter the lower maximum values instead of the nominal values of the transformers/transducers. The transformation ratio should of course be implemented correctly.

The current measuring range is selected with sec.I and a transformer/transducer error can be corrected.

sec.I (mA)	Secondary current transformer
900 ... 1100	1 A ±10%
4500 ... 5500	5 A ±10%

4.3.3 Dimensions of measured values

Subindexes 05_{hex} ... 08_{hex}

The validity of the measured values (i.e., the tens exponents referencing V, A, W or VA, VAr and Wh or VArh) is determined from the primary voltages and currents of the transformers/transducers.

The current measuring range is switched over with the “secondary phase current”; in the case of direct connection (prim.I = 0), this corresponds to a primary current of 1 A or 5 A.

If a voltage transducer is not being used (prim.U = 0), it corresponds to a primary voltage of 500 V for the dimension calculation.

Dimensions for direct connection, no transformer/transducer

prim.U = 0 sec.U = 0 prim.I = 0

Table 4-4 Dimensions for direct connection, no transformer/transducer

Nominal current corresponds to prim.I	Setting with sec.I	Dim.I	Dim.U	Dim.P	Dim.E
1 A	1000 (<= 1200)	-4	-1	-1	-4
5 A	5000 (> 1200)	-3	-1	0	-3

Dimensions with transformer/transducer

Table 4-5 Dimensions with transformer/transducer

prim.I (A)	Dim.I
> 10 k	1
> 1 k ... 10 k	0
101 ... 1000	-1
11 ... 100	-2
2 ... **5** ... 10	-3
1	-4

prim.U (V)	Dim.U
> 10 k	1
> 1 k ... 10 k	0
101 ... **500** ... 1000	-1
100	-2

Table 4-6 Dimensions with transformer/transducer

prim.I x prim.U (W)	Dim.P	Dim.E
> 500 M	6	3
> 50 M ... 500 M	5	2
> 5 M ... 50 M	4	1
> 500 k ... 5 M	3	0
> 50 k ... 500 k	2	-1
> 5 k ... 50 k	1	-2
> 500 ... **2500** ... 5000	0	-3
100 ... **500**	-1	-4

4.3.4 S0 pulse source

Subindex 09_{hex}

The S0 pulse WORD is included in the process data at control word 0200_{hex}.

(For a description, see PCP object 0082_{hex})

Table 4-7 S0 pulse source

Bit	Value	What
0, 1	**0**	Real energy consumption
	1	Real energy supply
	2	Reactive energy inductive
	3	Reactive energy capacitive
2 ... 7	**0**	–

4.3.5 Connection method

Subindex $0A_{hex}$

See also “Connection according to network type” on page 2-3.

Table 4-8 Connection method

Bit	Value	Connection method
0 ... 2	**0**	Three-phase
	1	–
	2	Open-Y economy circuit
	3	–
	4	I1 + L1-N economy circuit
	5	I1 + L1-L3 economy circuit
	6	Single-phase AC current
	7	Two-phase network split phase
3	**0**	–
4	0	Neutral conductor not connected
	1	Neutral conductor connected
5	0	Neutral conductor current not connected
	1	Neutral conductor current connected
6, 7	**0**	–

4.3.6 Reactive power display

Subindex $0B_{hex}$

For the calculation of the reactive power and power factor, apart from the standardized formulae others are commonly used which have more practical relevance.

Table 4-9 Reactive power display

Bit	What	Value	How
0 ... 6	–	**0**	–
7	Capacitive	**0**	3rd + 4th quadrant
		1	2nd + 4th quadrant

4.3.7 Frequency synchronization

Subindex $0C_{hex}$

All measurements are mains synchronous, in order to prevent interference during measurement, which could lead to fluctuating measured values.

If synchronization cannot be carried out, the set mains frequency is used.

Table 4-10 Frequency synchronization

Bit	What	Value	How
0	Nominal frequency	**0**	50 Hz
		1	60 Hz
1, 2	Phase selection for synchronization	**0**	Automatic, phase with maximum signal level
		1	U1 fixed
		2	U2 fixed
		3	U3 fixed
3 ... 7		**0**	–

4.3.8 Averaging time

Subindex $0D_{hex}$

The setting range is not limited, for the function the set time is converted to the closest number of full waves.

Table 4-11 Averaging time

Operating mode	Setting range	Averaging over ...
Basic measured values	Approx. 15 ms .... 32 s	1, 2, 4, 8, 12 full waves ... multiple of 4 full waves
Scanning values	0/> 0	64/32 scanning values per full wave
Synchronization	–	1 full wave fixed

4.4 Objects with measured values, diagnostics, and control

The following objects are only defined for basic measured values mode.

Maximum values in the objects are mapped by amount.

Table 4-12 0081_{hex}: Basic Values

Object	Basic Values			
Access	Read only			
Data	Phase voltages, currents, real powers			
Data type	Array of INT			11 x 2 bytes
$Index_{hex}$	0081			
$Subindex_{hex}$	00	Record	Read all elements	
	01	INT	Phase voltage 1	in $10^{Dim.U}$ V
	02	INT	Phase voltage 2	
	03	INT	Phase voltage 3	
	04	INT	Phase current 1	in $10^{Dim.I}$ A
	05	INT	Phase current 2	
	06	INT	Phase current 3	
	07	INT	Neutral conductor current	
	08	INT	Real power 1	in $10^{Dim.P}$ W
	09	INT	Real power 2	
	0A	INT	Real power 3	
	0B	INT	Total real power	

Table 4-13 0082_{hex}: Extended Values

Object	Extended Values			
Access	Read only			
Data	Phase conductor voltages, bimetal current measurement, frequency			
Data type	Array of INT			10 x 2 bytes
$Index_{hex}$	0082			
$Subindex_{hex}$	00	Record	Read all elements	
	01	INT	Phase conductor voltage 12	in $10^{Dim.U}$ V
	02	INT	Phase conductor voltage 23	
	03	INT	Phase conductor voltage 31	
	04	INT	Phase current 1 filtered	in $10^{Dim.I}$ A Time response same as for a bimetal measuring device
	05	INT	Phase current 2 filtered	
	06	INT	Phase current 3 filtered	
	07	INT	Neutral conductor current filtered	
	08	INT	Frequency	in 0.01 Hz
	09	WORD	Energy direction	Bit 0/1 = 0 Consumption/supply Phase 1 1 Consumption/supply Phase 2 2 Consumption/supply Phase 3 3 Consumption/supply Total 4 Inductive/capacitive Phase 1 5 Inductive/capacitive Phase 2 6 Inductive/capacitive Phase 3 7 Inductive/capacitive Total 8 ... 15 –
	0A	WORD	S0 pulses	Bit 0/1 = 0 OFF/ON 1 per 100 digits 4 OFF/ON 1 per 1000 digits 8 OFF/ON 1 per 10000 digits References the energy values in object 0084_{hex}

Table 4-14 0083_{hex}: Power

Object	Power			
Access	Read only			
Data	Reactive and apparent powers, power factors			
Data type	Array of INT			11 x 2 bytes
$Index_{hex}$	0083			
$Subindex_{hex}$	00	Record	Read all elements	
	01	INT	Reactive power 1	in $10^{Dim.P}$ VAr
	02	INT	Reactive power 2	
	03	INT	Reactive power 3	
	04	INT	Apparent power 1	in $10^{Dim.P}$ VA
	05	INT	Apparent power 2	
	06	INT	Apparent power 3	
	07	INT	Total apparent power	
	08	INT	Power factor 1	in 0.001
	09	INT	Power factor 2	
	0A	INT	Power factor 3	
	0B	INT	Total power factor	

Table 4-15 0084_{hex}: Energy

Object	Energy			
Access	Read/write Write permitted for pre-assignments, as the terminal does not have a non-volatile memory.			
Data	Real and reactive energies, separated according to consumption/supply and inductive/capacitive			
Data type	Array of DINT			5 x 4 bytes
$Index_{hex}$	0084			
$Subindex_{hex}$	00	Record	Read/write all elements	
	01	DINT	Real energy consumption	in $10^{Dim.E}$ Wh
	02	DINT	Real energy supply	
	03	DINT	Reactive energy inductive	in $10^{Dim.E}$ VArh
	04	DINT	Reactive energy capacitive	
	05	UDINT	Operating hours	in s

Table 4-16 0085_{hex}: Interval Power

Object	Interval Power			
Access	Read only			
Data	Interval powers			
Data type	Array of INT			9 x 2 bytes
$Index_{hex}$	0085			
$Subindex_{hex}$	00	Record	Read all elements	
	01	INT	Current interval real power	in $10^{Dim.P}$ W
	02	INT	Elapsed interval real power	
	03	INT	Maximum interval real power	
	04	INT	Current interval reactive power	in $10^{Dim.P}$ VAr
	05	INT	Elapsed interval reactive power	
	06	INT	Maximum interval reactive power	
	07	INT	Current interval apparent power	in $10^{Dim.P}$ VA
	08	INT	Elapsed interval apparent power	
	09	INT	Maximum interval apparent power	

Table 4-17 0086_{hex}: Reactive Power

Object	Reactive Power			
Access	Read only			
Data	Reactive power, cos(phi)			
Data type	Array of INT			10 x 2 bytes
$Index_{hex}$	0086			
$Subindex_{hex}$	00	Record	Read all elements	
	01	INT	Distortion reactive power 1	in $10^{Dim.P}$ VAr
	02	INT	Distortion reactive power 2	
	03	INT	Distortion reactive power 3	
	04	INT	Reactive power 1 (according to standard)	
	05	INT	Reactive power 2 (according to standard)	
	06	INT	Reactive power 3 (according to standard)	
	07	INT	Total reactive power (according to standard)	
	08	INT	cos(phi) 1	in 0.001
	09	INT	cos(phi) 2	
	0A	INT	cos(phi) 3	

Table 4-18 0087_{hex}: Synchronization

Object	Synchronization			
Access	Read only			
Data	Values for synchronization			
Data type	Array of INT			7 x 2 bytes
$Index_{hex}$	0087			
$Subindex_{hex}$	00	Record	Read all elements	
	01	INT	Phase voltage 1	in $10^{Dim.U}$ VAr
	02	INT	Phase voltage 2	
	03	INT	Phase voltage 3	
	04	INT	Angle phase 2 - phase 1	in 0.1 degrees
	05	INT	Angle phase 2 - phase 1 for PLL	
	06	INT	Frequency phase 1	in 0.01 Hz
	07	INT	Frequency difference phase 2 - phase 1	

Table 4-19 0088_{hex}: Data Sample

Object	Data Sample			
Access	Read/write			
Data	Configurable data record An element of this object is a record and contains the PCP object address of the value to be displayed in the IN process data. The composition of the process data is determined by the objects referenced. If the total length exceeds 11 words, the data record must be rejected. (Negative PCP response, see INTERBUS basic profile)			
Data type	Array of Record			11 x 4 bytes
$Index_{hex}$	0088			
$Subindex_{hex}$	00	Record	Read or write all elements	
	01	Record	16-bit object index (bit 15 ... bit 8)	
			16-bit object index (bit 7 ... bit 0)	
			8-bit subindex	
			Length of the ref. object in bytes (e.g., INT = 2 or DINT = 4)	
	…	…	…	
	…	…	…	
	…	…	…	
	0B	Record	16-bit object index (bit 15 ... bit 8)	
			16-bit object index (bit 7 ... bit 0)	
			8-bit subindex	
			Length of the object in bytes (e.g., INT = 2 or DINT = 4)	

Table 4-20 $008C_{hex}$: Short-time Control

Object	Short-timeControl			
Access	Read/write			
Data	Control commands			
Data type	INT			2 bytes
$Index_{hex}$	008C			
$Subindex_{hex}$	00	INT	Read/write element	
	01	INT	Command word	See “Objects with measured values, diagnostics, and control” on page 4-10 for the bit assignment.

Table 4-21 0091_{hex}: Maximal Basic Values

Object	Maximal Basic Values			
Access	Read only			
Data	Maximum values of the phase voltages, currents, real powers			
Data type	Array of INT			11 x 2 bytes
$Index_{hex}$	0091			
$Subindex_{hex}$	00	Record	Read all elements	
	01	INT	Maximum phase voltage 1	in $10^{Dim.U}$ V
	02	INT	Maximum phase voltage 2	
	03	INT	Maximum phase voltage 3	
	04	INT	Maximum phase current 1	in $10^{Dim.I}$ A
	05	INT	Maximum phase current 2	
	06	INT	Maximum phase current 3	
	07	INT	Maximum neutral conductor current	
	08	INT	Maximum real power 1	in $10^{Dim.P}$ W
	09	INT	Maximum real power 2	
	0A	INT	Maximum real power 3	
	0B	INT	Total maximum real power	

Table 4-22 0092_{hex}: Maximal Extended Values

Object	Maximal Extended Values			
Access	Read only			
Data	Maximum values of phase conductor voltages, bimetal current measurement			
Data type	Array of INT			7 x 2 bytes
$Index_{hex}$	0092			
$Subindex_{hex}$	00	Record	Read all elements	
	01	INT	Maximum phase conductor voltage 12	in $10^{Dim.U}$ V
	02	INT	Maximum phase conductor voltage 23	
	03	INT	Maximum phase conductor voltage 31	
	04	INT	Maximum phase current 1 filtered	in $10^{Dim.I}$ A Time response same as for a bimetal measuring device
	05	INT	Maximum phase current 2 filtered	
	06	INT	Maximum phase current 3 filtered	
	07	INT	Maximum neutral conductor current filtered	

Table 4-23 0093_{hex}: Maximal Power

Object	Maximal Power			
Access	Read only			
Data	Maximum values of the reactive and apparent powers, minimum values of the power factors			
Data type	Array of INT			11 x 2 bytes
$Index_{hex}$	0093			
$Subindex_{hex}$	00	Record	Read all elements	
	01	INT	Maximum reactive power 1	in $10^{Dim.P}$ VAr
	02	INT	Maximum reactive power 2	
	03	INT	Maximum reactive power 3	
	04	INT	Maximum apparent power 1	in $10^{Dim.P}$ VA
	05	INT	Maximum apparent power 2	
	06	INT	Maximum apparent power 3	
	07	INT	Total maximum apparent power	
	08	INT	Minimum power factor 1	in 0.001
	09	INT	Minimum power factor 2	
	0A	INT	Minimum power factor 3	
	0B	INT	Total minimum power factor	

Table 4-24 0096_{hex}: Maximal Reactive Power

Object	Maximal Reactive Power			
Access	Read only			
Data	Maximum values for reactive power, cos(phi)			
Data type	Array of INT			10 x 2 bytes
$Index_{hex}$	0096			
$Subindex_{hex}$	00	Record	Read all elements	
	01	INT	Maximum distortion reactive power 1	in $10^{Dim.P}$ VAr
	02	INT	Maximum distortion reactive power 2	
	03	INT	Maximum distortion reactive power 3	
	04	INT	Maximum reactive power 1 (according to standard)	
	05	INT	Maximum reactive power 2 (according to standard)	
	06	INT	Maximum reactive power 3 (according to standard)	
	07	INT	Total maximum reactive power (according to standard)	
	08	INT	cos(phi) 1	in 0.001
	09	INT	cos(phi) 2	
	0A	INT	cos(phi) 3	

Table 4-25 $009D_{hex}$: PD Diag State

Object	PD Diag State			
Access	Read only			
Data	Diagnostic bits as for process data			
Data type	Record			3 bytes
$Index_{hex}$	009D			
$Subindex_{hex}$	00	Record	Read all elements	
	01	BYTE	Input error	Bit 0 Current phase 1 out of tolerance Bit 1 Current phase 2 out of tolerance Bit 2 Current phase 3 out of tolerance Bit 3 Neutral conductor current out of tolerance Bit 4 Voltage phase 1 out of tolerance Bit 5 Voltage phase 2 out of tolerance Bit 6 Voltage phase 3 out of tolerance Bit 7 Frequency out of tolerance
	02	WORD	Diagnostic word	See “Diagnostic word in IN1 (control word 1D00hex)” on page 3-15

Table 4-26 $00A0_{hex}$: Total Harmonic Distortion

Object	Total Harmonic Distortion			
Access	Read only			
Data	Distortion of voltages (referencing the fundamental wave) and currents			
Data type	Array of INT			7 x 2 bytes
$Index_{hex}$	00A0			
$Subindex_{hex}$	00	Record	Read all elements	
	01	INT	Total distortion phase voltage 1	in 0.001
	02	INT	Total distortion phase voltage 2	
	03	INT	Total distortion phase voltage 3	
	04	INT	Total distortion phase current 1	in $10^{Dim.I}$ A
	05	INT	Total distortion phase current 2	
	06	INT	Total distortion phase current 3	
	07	INT	Total distortion neutral conductor current	

Table 4-27 $00A1_{hex}$: Harmonic Distortion U1

Object	Harmonic Distortion U1			
Access	Read only			
Data	1st to 31st harmonics of phase voltage 1 referencing fundamental wave			
Data type	Array of INT			(29 + 2) x 2 bytes
$Index_{hex}$	00A1			
$Subindex_{hex}$	00	Record	Read all elements	
	01	INT	U1 referencing fundamental wave	in 0.001
	02	INT	2nd harmonic distortion of U1	
	...	...	...	
	1D	INT	29th harmonic distortion of U1	
	1E	INT	30th harmonic distortion of U1	Can only be read via subindexes
	1F	INT	31st harmonic distortion of U1	

Table 4-28 $00A2_{hex}$: Harmonic Distortion U2

Object	Harmonic Distortion U2			
Access	Read only			
Data	1st to 31st harmonics of phase voltage 2 referencing fundamental wave			
Data type	Array of INT			(29 + 2) x 2 bytes
$Index_{hex}$	00A2			
$Subindex_{hex}$	00	Record	Read all elements	
	01	INT	U2 referencing fundamental wave	in 0.001
	02	INT	2nd harmonic distortion of U2	
	...	...	...	
	1D	INT	29th harmonic distortion of U2	
	1E	INT	30th harmonic distortion of U2	Can only be read via subindexes
	1F	INT	31st harmonic distortion of U2	

Table 4-29 $00A3_{hex}$: Harmonic Distortion U3

Object	Harmonic Distortion U3			
Access	Read only			
Data	1st to 31st harmonics of phase voltage 3 referencing fundamental wave			
Data type	Array of INT			(29 + 2) x 2 bytes
$Index_{hex}$	00A3			
$Subindex_{hex}$	00	Record	Read all elements	
	01	INT	U3 referencing fundamental wave	in 0.001
	02	INT	2nd harmonic distortion of U3	
	...	...	...	
	1D	INT	29th harmonic distortion of U3	
	1E	INT	30th harmonic distortion of U3	Can only be read via subindexes
	1F	INT	31st harmonic distortion of U3	

Table 4-30 $00A4_{hex}$: Harmonics I1

Object	Harmonics I1			
Access	Read only			
Data	1st to 31st harmonics of phase current 1			
Data type	Array of INT			(29 + 2) x 2 bytes
$Index_{hex}$	00A4			
$Subindex_{hex}$	00	Record	Read all elements	
	01	INT	Fundamental wave of I1	in $10^{Dim.I}$ A
	02	INT	2nd harmonic of I1	
	...	...	...	
	1D	INT	29th harmonic of I1	
	1E	INT	30th harmonic of I1	Can only be read via subindexes
	1F	INT	31st harmonic of I1	

Table 4-31 $00A5_{hex}$: Harmonics I2

Object	Harmonics I2			
Access	Read only			
Data	1st to 31st harmonics of phase current 2			
Data type	Array of INT			(29 + 2) x 2 bytes
$Index_{hex}$	00A5			
$Subindex_{hex}$	00	Record	Read all elements	
	01	INT	Fundamental wave of I2	in $10^{Dim.I}$ A
	02	INT	2nd harmonic of I2	
	...	...	...	
	1D	INT	29th harmonic of I2	
	1E	INT	30th harmonic of I2	Can only be read via subindexes
	1F	INT	31st harmonic of I2	

Table 4-32 $00A6_{hex}$: Harmonics I3

Object	Harmonics I3			
Access	Read only			
Data	1st to 31st harmonics of phase current 3			
Data type	Array of INT			(29 + 2) x 2 bytes
$Index_{hex}$	00A6			
$Subindex_{hex}$	00	Record	Read all elements	
	01	INT	Fundamental wave of I3	in $10^{Dim.I}$ A
	02	INT	2nd harmonic of I3	
	...	...	...	
	1D	INT	29th harmonic of I3	
	1E	INT	30th harmonic of I3	Can only be read via subindexes
	1F	INT	31st harmonic of I3	

Table 4-33 $00A7_{hex}$: Harmonics IN

Object	Harmonics IN			
Access	Read only			
Data	1st to 31st harmonics of the neutral conductor current			
Data type	Array of INT			(29 + 2) x 2 bytes
$Index_{hex}$	00A7			
$Subindex_{hex}$	00	Record	Read all elements	
	01	INT	Fundamental wave of IN	in $10^{Dim.I}$ A
	02	INT	2nd harmonic of IN	
	...	...	...	
	1D	INT	29th harmonic of IN	
	1E	INT	30th harmonic of IN	Can only be read via subindexes
	1F	INT	31st harmonic of IN	

Table 4-34 $00B0_{hex}$: Maximal Total Harmonic Distortion

Object	Maximal Total Harmonic Distortion			
Access	Read only			
Data	Maximum values of distortion of voltages (referencing the fundamental wave) and currents			
Data type	Array of INT			7 x 2 bytes
$Index_{hex}$	00B0			
$Subindex_{hex}$	00	Record	Read all elements	
	01	INT	Maximum total distortion phase voltage 1	in 0.001
	02	INT	Maximum total distortion phase voltage 2	
	03	INT	Maximum total distortion phase voltage 3	
	04	INT	Maximum total distortion phase current 1	in $10^{Dim.I}$ A
	05	INT	Maximum total distortion phase current 2	
	06	INT	Maximum total distortion phase current 3	
	07	INT	Maximum total distortion neutral conductor current	

Table 4-35 $00B1_{hex}$: Maximal Harmonic Distortion U1

Object	Maximal Harmonic Distortion U1			
Access	Read only			
Data	Maximum 1st to 31st harmonics of phase voltage 1 referencing fundamental wave			
Data type	Array of INT			(29 + 2) x 2 bytes
$Index_{hex}$	00B1			
$Subindex_{hex}$	00	Record	Read all elements (01 ... 1D)	
	01	INT	Maximum U1 referencing fundamental wave	in 0.001
	02	INT	Maximum 2nd harmonic distortion of U1	
	...	...	...	
	1D	INT	Maximum 29th harmonic distortion of U1	
	1E	INT	Maximum 30th harmonic distortion of U1	Can only be read via subindexes
	1F	INT	Maximum 31st harmonic distortion of U1	

Table 4-36 $00B2_{hex}$: Maximal Harmonic Distortion U2

Object	Maximal Harmonic Distortion U2			
Access	Read only			
Data	Maximum 1st to 31st harmonics of phase voltage 2 referencing fundamental wave			
Data type	Array of INT			(29 + 2) x 2 bytes
$Index_{hex}$	00B2			
$Subindex_{hex}$	00	Record	Read all elements (01 ... 1D)	
	01	INT	Maximum U2 referencing fundamental wave	in 0.001
	02	INT	Maximum 2nd harmonic distortion of U2	
	...	...	...	
	1D	INT	Maximum 29th harmonic distortion of U2	
	1E	INT	Maximum 30th harmonic distortion of U2	Can only be read via subindexes
	1F	INT	Maximum 31st harmonic distortion of U2	

Table 4-37 $00B3_{hex}$: Maximal Harmonic Distortion U3

Object	Maximal Harmonic Distortion U3			
Access	Read only			
Data	Maximum 1st to 31st harmonics of phase voltage 3 referencing fundamental wave			
Data type	Array of INT			(29 + 2) x 2 bytes
$Index_{hex}$	00B3			
$Subindex_{hex}$	00	Record	Read all elements (01 ... 1D)	
	01	INT	Maximum U3 referencing fundamental wave	in 0.001
	02	INT	Maximum 2nd harmonic distortion of U3	
	...	...	...	
	1D	INT	Maximum 29th harmonic distortion of U3	
	1E	INT	Maximum 30th harmonic distortion of U3	Can only be read via subindexes
	1F	INT	Maximum 31st harmonic distortion of U3	

Table 4-38 $00B4_{hex}$: Maximal Harmonics I1

Object	Maximal Harmonics I1			
Access	Read only			
Data	Maximum 1st to 31st harmonics of phase current 1			
Data type	Array of INT			(29 + 2) x 2 bytes
$Index_{hex}$	00B4			
$Subindex_{hex}$	00	Record	Read all elements (01 ... 1D)	
	01	INT	Maximum fundamental wave of I1	in $10^{Dim.I}$ A
	02	INT	Maximum 2nd harmonic of I1	
	...	...	...	
	1D	INT	Maximum 29th harmonic of I1	
	1E	INT	Maximum 30th harmonic of I1	Can only be read via subindexes
	1F	INT	Maximum 31st harmonic of I1	

Table 4-39 $00B5_{hex}$: Maximal Harmonics I2

Object	Maximal Harmonics I2			
Access	Read only			
Data	Maximum 1st to 31st harmonics of phase current 2			
Data type	Array of INT			(29 + 2) x 2 bytes
$Index_{hex}$	00B5			
$Subindex_{hex}$	00	Record	Read all elements (01 ... 1D)	
	01	INT	Maximum fundamental wave of I2	in $10^{Dim.I}$ A
	02	INT	Maximum 2nd harmonic of I2	
	...	...	...	
	1D	INT	Maximum 29th harmonic of I2	
	1E	INT	Maximum 30th harmonic of I2	Can only be read via subindexes
	1F	INT	Maximum 31st harmonic of I2	

Table 4-40 $00B6_{hex}$: Maximal Harmonics I3

Object	Maximal Harmonics I3			
Access	Read only			
Data	Maximum 1st to 31st harmonics of phase current 3			
Data type	Array of INT			(29 + 2) x 2 bytes
$Index_{hex}$	00B6			
$Subindex_{hex}$	00	Record	Read all elements (01 ... 1D)	
	01	INT	Maximum fundamental wave of I3	in $10^{Dim.I}$ A
	02	INT	Maximum 2nd harmonic of I3	
	...	...	...	
	1D	INT	Maximum 29th harmonic of I3	
	1E	INT	Maximum 30th harmonic of I3	Can only be read via subindexes
	1F	INT	Maximum 31st harmonic of I3	

Table 4-41 $00B7_{hex}$: Maximal Harmonics IN

Object	Maximal Harmonics IN			
Access	Read only			
Data	Maximum 1st to 31st harmonics of the neutral conductor current			
Data type	Array of INT			(29 + 2) x 2 bytes
$Index_{hex}$	00B7			
$Subindex_{hex}$	00	Record	Read all elements (01 ... 1D)	
	01	INT	Maximum fundamental wave of IN	in $10^{Dim.I}$ A
	02	INT	Maximum 2nd harmonic of IN	
	...	...	...	
	1D	INT	Maximum 29th harmonic of IN	
	1E	INT	Maximum 30th harmonic of IN	Can only be read via subindexes
	1F	INT	Maximum 31st harmonic of IN	

A Technical appendix: Error messages

Table A-1 Error messages

Error	Error handling
Logic part	
Failure of communications power	Module switches off, “D” LED, “TR” LED, and “E” LED off
Voltage paths	
Two phase conductors mixed up	“E” LED on and error bit set (IN0, bit 15) but only if required according to the connection method Diagnostic word = 0010_{hex} only for connection method with rotating field
One phase conductor not connected or phase conductor open circuit	“E” LED on and error bit set (IN0, bit 15) but only if required according to the connection method Diagnostic word = 0020_{hex} only for connection method with rotating field Diagnostic word = 0040_{hex} always
Neutral conductor not connected or open circuit	Cannot be measured, value = 0 for symmetrical network
Overload	“E” LED on and input error bit set (IN0, bit 4 ... 6)
Measuring circuit fault	“E” LED on and error bit set (IN0, bit 15) Diagnostic word = 4000_{hex}
Current paths	
Open circuit	Cannot be measured, current = 0 is permitted
Phase sequence of connected current transformer is incorrect	Displayed as a negative power (supply) if power is actually being consumed Energy direction bit (0082_{hex}/09_{hex}/bit 0 ... 2) inverse
Overload	“E” LED on and input error bit set (IN0, bit 0 ... 3)
Measuring circuit fault	“E” LED on and error bit set (IN0, bit 15) Diagnostic word = 4000_{hex}
Configuration	
Value range for transformer/transducer factors exceeded	Error bit set (IN0, bit 15) Diagnostic word = 800_{hex}
Value range for other settings exceeded	Error bit set (IN0, bit 15) Diagnostic word = 1000_{hex}

B Appendix for document lists

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